# Adaptive Design of Beach Nourishment Projects

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Beach nourishment projects have been constructed and monitored intensively over the past several decades. Concurrently, a body of theory has been under development describing the evolution of beach nourishment projects. The availability of this combination of monitoring results and theory provides a sound basis for a much more rapid and reliable design process with confidence than was possible a decade or two ago. In particular, it is possible, with considerable less costs and efforts, to design projects, which will perform effectively. An element of these projects is a monitoring program which allows: (1) Refined design for future renourishments, and (2) Modification of prediction performance for future renourishments.

The recently available theoretical results, which allow the designer to focus efforts on critical elements include: (1) Beach nourishment projects are effective "integrators" of wave energy. Thus, the sequence of storms causing evolution of the project is relatively unimportant. Moreover, it is possible to quantify a single "effective wave height" which will cause the same project evolution as a particular storm history, (2) For nourishment on a long straight beach with compatible sand, the evolution of a beach nourishment project is nearly independent of wave direction and is nearly symmetric, and (3) The longevity of beach nourishment projects is proportional to the square of the length of the project and inversely proportional to the 2.5 power of the wave height. Moreover, results are available to approximate the effects of nourishing with sand that is not compatible with the native. The above principles may differ and be somewhat more complex for unique geographic settings of the project, for example, downdrift of a channel with no bypassing.

Adaptive beach nourishment design includes five components: (1) A "fast track" design employing the principles above and tools that herein are referred to as "simple" but which can be shown to yield reasonable results. In areas where these tools are not available, this will require a one-time development, (2) As part of the design phase, prediction of the physical performance of the project, (3) Education of the Stakeholders to ensure that they understand the strategy and confidence levels associated with the design, (4) Monitoring to document the performance of the project, and (5) Incorporation of the monitoring results into later renourishments and quantification and interpretation of the causes of any differences between predictions and monitoring results.

The four most critical elements of a beach nourishment project to its performance are the quality and quantity of the sand, the project length, and the background erosion. Ideally, the nourishment sand should provide a reasonably close “match” to or be slightly coarser than the native sand. If this match is not achieved, methods are available to account for the differences. The quantity of nourishment sand placed per unit beach length is referred to as the nourishment density and is key to the project performance. One benefit of a substantial volume density is that because the project will not perform equally along its length, a “buffer” of excess sand ensures that areas of relatively poor performance will not return the beach locally to approximately the pre-nourishment conditions. Additionally, an excess of sand will provide a reservoir such that sand spread out to adjacent shorelines will not result in a need for early mobilization for renourishment. Recommended nourishment volume densities along the Florida east coast are approximately 100 cubic yards per foot of beach length although appropriate densities vary with wave climate. The performance benefits of long projects have been discussed. Doubling the project length quadruples its life and tripling the length increases the life by a factor of nine! Unless the cause of background erosion is recognized and corrected prior to construction of the nourishment project, it is assumed that the background erosion will continue at the same rate after nourishment.

Simple design tools have been developed for the Florida shoreline, can be developed for other areas, and will be illustrated in the presentation. With the availability of these tools, accomplishment of the design is possible within a relatively short time and the predicted performance should be as reliable as for much more time consuming and detailed approaches. Reasons include uncertainties over the actual versus design wave climate and inherent limitations imposed by our lack of detailed understanding of sediment transport processes. This will allow resources to be directed to monitoring and interpretation of monitoring results with emphasis on differences between predicted and actual performance. An information/educational component to the Stakeholders throughout the design, construction and later phases should be incorporated into the entire process.